U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1580

MYCOLOGY
JAN 1930

CIGAR-TOBACCO PRODUCTION *in* PENNSYLVANIA

TWO PRINCIPAL TYPES of cigar-leaf tobacco are grown in Pennsylvania—namely, Pennsylvania Broadleaf or Seedleaf and Pennsylvania Havana Seed. The former is a filler type and the latter is mainly a binder type. This bulletin contains concise recommendations and instructions for growing, curing, and handling these two types and for fermenting cigar-leaf tobacco. Filler leaf is produced in Lancaster and adjoining counties, whereas binder leaf is grown mainly in Clinton, Tioga, Lycoming, and Bradford Counties. Lancaster County produces the bulk of the tobacco crop of the State.

In the filler district, tobacco is grown in a rotation system which includes wheat, alfalfa or clover, and corn, and the manure derived from the feeding of steers is applied to the tobacco crop. Tobacco seed beds are steam sterilized and the plants are set by machine. Commercial fertilizer as a supplement to manure usually gives profitable returns by improving the quality as well as the yield of the crop. For best results the crop must be allowed to become fully mature before harvest. In the curing process the use of artificial heat is necessary, when unfavorable weather conditions prevail, in order to avoid damage from pole sweat or house burn. Growers are paying more attention to systematic selection of seed plants in order to obtain greater uniformity of output.

Methods of production in the binder districts are, in many respects, similar to those in the filler districts. Important differences are (1) the use of the Havana Seed instead of the Broadleaf variety of seed; (2) continuous culture of tobacco rather than rotation of crops; (3) the replacement of manure by commercial fertilizers in some counties; (4) closer spacing of plants in the field; (5) the absence of the dampening cellar as an aid in conditioning the tobacco for stripping, except in Clinton and Lycoming Counties.

This bulletin supersedes Farmers' Bulletin 416, The Production of Cigar-Leaf Tobacco in Pennsylvania.

Washington, D. C. Issued July, 1929

CIGAR-TOBACCO PRODUCTION IN PENNSYLVANIA

By Otto Olson, *Associate Agronomist, Office of Tobacco and Plant Nutrition, Bureau of Plant Industry*

CONTENTS

	Page		Page
Introduction	1	Cultural operations—Continued.	
Cropping systems	2	Suckering	11
Cultural operations	4	Harvesting	11
Seed beds	4	Curing	12
Field preparation	7	Stripping	13
Tobacco fertilizers	7	Marketing	15
Transplanting	8	Tobacco-plant diseases	16
Cultivation	9	Seed selection	18
Topping	10	Fermentation or sweating process	19

INTRODUCTION

WHILE it is believed that the colonists brought over by William Penn in 1682 engaged in growing tobacco in the neighborhood of where Philadelphia is now located, no authentic information is available as to the type and quantities produced at that time. It is stated, however, in an old history of Pennsylvania that 14 cargoes of tobacco were shipped from Philadelphia in 1689. The introduction of cigar-leaf tobacco into Pennsylvania probably did not occur until 1828, when several acres of Connecticut Broadleaf were grown in the vicinity of Ephrata, Lancaster County. By 1845 the culture of this tobacco had spread to Clinton County, and in 1851 it was fairly well under way along the banks of the Susquehanna River and its branches in Lycoming, Bradford, and Tioga Counties.

The total production of cigar-leaf tobacco in Pennsylvania has increased from 325,018 pounds in 1839 to 57,400,000 pounds in 1925. In Lancaster County, which produces about 90 per cent of the crop, tobacco is grown mostly on loamy soils of limestone origin, the variety grown being a cigar-filler type commonly known as Pennsylvania Broadleaf or Seedleaf, which is classified by the Department of Agriculture as United States type 41.[1] This type is also grown in York, Berks, Chester, Lebanon, and Dauphin Counties and to a small extent in a number of other counties. Clinton, Tioga, Lycoming, and Bradford Counties produce a cigar-binder type from Havana Seed, which is classified as United States type 53.[1] This type is grown chiefly on the sandy loams of the river valleys.

[1] The Bureau of Agricultural Economics of the U. S. Department of Agriculture has classified the leading types of American-grown tobacco with a definite type number, so as to avoid the confusion that often arises from the use of various type names in the trade. This classification is being used for statistical purposes and forms a basis for standard tobacco grades.

A well-defined demand exists for the cigar-filler tobacco produced in Pennsylvania, and it is used extensively in the manufacture of domestic cigars because of its excellent blending qualities. It is well adapted for this purpose because of its texture, flavor, and aroma. While the growers have not yet fully realized the importance of paying attention to uniformity of type, much headway has been gained in recent years toward establishing a uniform type or strain of Pennsylvania Broadleaf in Lancaster and adjoining counties.

The cigar-binder tobacco produced in Pennsylvania does not occupy quite so prominent a position in trade circles as the cigar filler, mainly because it can be grown successfully only on the light, sandy loams found in certain localities along the river valleys. The acreage devoted to the culture of this type of tobacco, Havana Seed, has decreased considerably during the last 30 years. In Tioga County, for example, 1,785 acres of Havana Seed tobacco were grown in 1899, whereas in 1925 only 360 acres were planted. The causes of this decline are primarily the absence of local markets and warehouses, unsatisfactory methods of handling the tobacco, and the lack of uniform types.

Quite a difference exists in the methods of growing and handling the two types of tobacco produced in Pennsylvania, and it is the purpose of this bulletin to describe present cultural methods and to point out ways by which these methods may be improved.

CROPPING SYSTEMS

As a general rule, tobacco is grown under a definite rotation plan in all counties where cigar-filler tobacco is produced, while nearly all cigar-binder tobacco is produced by continuous cropping on the same fields.

The rotation chiefly practiced in Lancaster, York, Chester, Berks, Lebanon, and Dauphin Counties is a 4-year system of (1) tobacco, (2) wheat, (3) clover or alfalfa, and (4) corn, though some growers use a 3-year rotation system consisting of (1) tobacco, (2) wheat, and (3) clover or alfalfa. It is generally believed that tobacco grown under the 3-year system has better quality and yield, as it follows sod, while tobacco grown under the 4-year system follows corn, which requires more plant food than the other crops, and consequently exhausts the soil more quickly. On some of the larger farms a 5-year rotation is practiced, consisting of (1) tobacco, (2) wheat, (3) grass, (4) grass, and (5) corn.

The feeding of steers, and to some extent dairying, are a part of these farming systems, and all of the hay, corn, and straw are consumed on the farm, and quantities of concentrates are purchased in addition. Lancaster County alone feeds from 65,000 to 80,000 steers each year, or an average of between 7 and 8 per farm. Soil fertility is thus conserved by using plant food materials over and over again, instead of its being sold and carried away. In addition, quantities of cottonseed meal, linseed meal, bran, and corn are purchased, and the feeding of these concentrates produces manure well adapted to tobacco growing. (Fig. 1.)

This farming system provides a remarkably good seasonal distribution of labor and enables the farmers to hire help by the year. Thus, during the spring months tobacco seed beds are prepared and

seeded; the fields are plowed for corn and tobacco; the steers are cared for, preparatory to their sale in April or May; and the corn is planted. During June and July the tobacco is planted, field crops are cultivated, and the hay and wheat crops are harvested. Tobacco cultivation, topping, suckering, and harvesting are attended to during the late summer months, while during the fall months tobacco curing, wheat soil preparation and seeding, as well as corn cutting, husking, and steer feeding occupy the farmers' time. Tobacco stripping is begun in December and continues well into March, together with steer feeding.

Cigar-binder or Havana Seed tobacco is usually grown on the same fields year after year in Clinton, Lycoming, Tioga, and Bradford Counties, though a few growers practice a limited crop rotation with grass and tobacco. In Tioga and Bradford Counties dairying is practiced extensively, and the resultant manure is used for the

FIGURE 1.—Steers such as are fed on practically all Lancaster County tobacco farms

tobacco crops. In Clinton and Lycoming Counties very little manure is obtainable, the growers depending chiefly on commercial fertilizers.

The tenant systems are of two forms. In one case the tenant operates the entire farm on the share basis, and in the other the tenant is simply a cropper and grows only tobacco. In the former case the landowner receives one-half the value of the crops and the tenant furnishes all the fertilizer and labor. Special inducements are usually offered by the owner to encourage the tenant to maintain a maximum number of livestock.

Under the cropper system the owner furnishes the land, the curing-shed space, the manure, sometimes half of any additional fertilizer applied, and prepares the soil for planting. The cropper furnishes the plants, all of the manual labor (using the owner's horses and equipment), and the paper and twine used in baling the tobacco. The owner and the cropper share equally in the sale value of the crop.

CULTURAL OPERATIONS

SEED BEDS

The seed beds should be located near a convenient water supply and as near as possible to the field to be planted. A southern exposure is preferred and also a position sheltered from the cold north winds. Tobacco seed beds in Pennsylvania are usually located in gardens, so that they may be utilized for the growing of vegetables after the tobacco plants are transplanted.

The beds consist of coldframes from 6 to 8 feet wide and any convenient length, the frames being made of 12-inch boards which are supported by stakes driven into the ground. Soil is banked around the lower edge of the boards to exclude insects and retain warmth, and after seeding cheesecloth or muslin is stretched over the upper edges of the boards and tacked down. To facilitate handling, the muslin may be fastened to light frames. Glass sashes also are used, especially in Lancaster, Tioga, and Bradford Counties, because they insure a more rapid growth, thus enabling the grower to set out his plants earlier, harvest the resultant crop sooner, and promote better curing of the tobacco. These advantages more than offset the additional cost over muslin. In Clinton County it is the custom to cover the seed beds with piles of brush after seeding, but muslin covers are gradually coming into use.

The tobacco seed beds in Pennsylvania are permanently placed. Consequently, there is danger of the development of destructive diseases unless the beds are steam sterilized. Sterilizing is done by applying steam from a boiler to a hood or pan inverted over the bed or part of bed, using a steam pressure of 125 pounds for 40 minutes on every portion of the bed by moving the pan as required. In Lancaster and Clinton Counties the steam-tractor owners usually supply the pans, the farmer being required to furnish coal and water for the boiler.

In order to sterilize the soil properly the beds should be dug, manured, and raked before the steaming is started. In this way the plant food contained in the manure and commercial fertilizer is made available more quickly, and more weed seeds and possible disease organisms in the manure are killed. Then all that is necessary to prepare the bed for seeding is to even up the surface of the soil by raking lightly.

Many benefits are derived from this treatment, and usually the cost is fully offset by the reduced weeding alone. In addition to killing weeds and insects, the sterilizing destroys a number of disease-producing organisms, reduces somewhat the quantity of fertilizer needed, and brings about a gain in plant growth, the plants from sterilized beds being large enough to transplant 7 to 10 days earlier than plants from unsteamed beds.

The addition of commercial fertilizer to manure on seed beds is advisable because plant growth is hastened, although if too much fertilizer is used the excessive rate of growth of the plants renders them more susceptible to disease. An application of 20 pounds of cottonseed meal, 8 pounds of superphosphate (acid phosphate), and 4 pounds of sulphate of potash to an area of 900 square feet of seed

bed has been found especially effective when used in addition to manure.

It is a common practice in Pennsylvania to "sprout" the seed; that is, induce partial or complete germination by immersing the seeds in warm water and keeping them in a warm room until germination starts. A few days may be thus gained, but the practice is not advisable, since the tender rootlets on the seedlings are easily injured during the process of seeding, and the sudden removal from a warm place to the cold soil of the seed bed is likely to react unfavorably on the growth. Although dry or unsprouted seeds take a few days longer to germinate, their subsequent growth will make up for any delay in germination.

The rate of seeding is important, because an overcrowded stand of plants results in poor, undeveloped root systems, with a decidedly

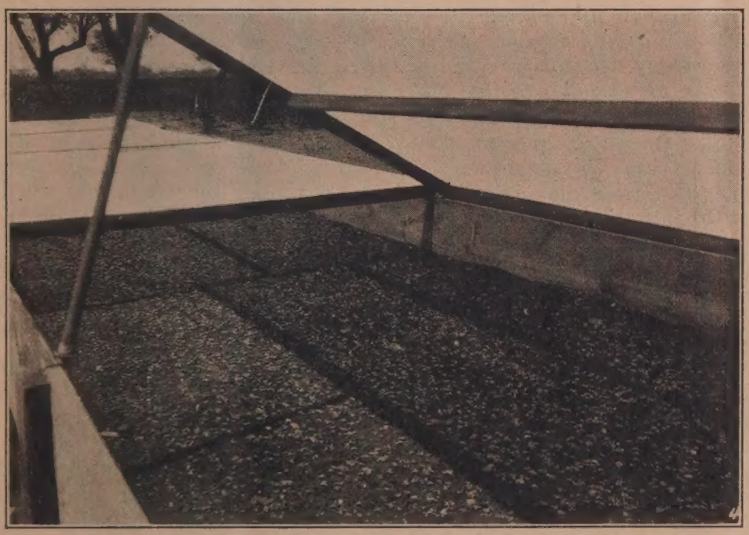

FIGURE 2.—Tobacco seed bed, showing a stand of about three plants to the square inch. The construction of muslin frames is also shown

slow growth after transplanting. Seeding at the rate of 1 level tablespoonful of good, recleaned seed to 200 square feet of seed bed should give a stand of three or four plants to the square inch. (Fig. 2.)

The necessity of good, carefully selected seed from a vigorous strain is apparent when the difference in yield in strains of the same variety is found to be as high as 500 pounds per acre, as shown by tests with the Broadleaf and Havana Seed varieties. Furthermore, the seed should be cleaned and graded so that all light, immature seeds are removed. Nearly all Pennsylvania tobacco growers are having their tobacco seed cleaned and graded every year with apparatus designed for the purpose.

Tobacco seeds are very small, 1 ounce containing about 300,000 seeds, so that in order to obtain a good, even stand of plants a careful

distribution is necessary in seeding. This may be done by using the "tobacco seeder," an ingenious contrivance much used in Lancaster County. Another efficient method consists in stirring the seed thoroughly in water and applying the mixture to the bed both lengthwise and crosswise by means of a sprinkling can. Another but less practical way of seeding is to mix the seed with several times its volume of sifted ashes. This mixture is sown evenly over the bed, and the soil surface is finally patted gently with a smooth board.

Sterilized beds should not be seeded until the day following the steaming, because the heat in the soil may kill seeds sown earlier.

The beds should be thoroughly watered after seeding and the surface of the soil covered with old muslin or sacks, which serve to retain moisture and warmth. Unless known to be free from disease organisms, these covers should be steamed or boiled before they are used. Hog bristles and straw are also used as a cover, but require much more labor in applying and removing. These covers must be removed as soon as the plants begin to come up. Moldy spots may appear where the covering rested, but these spots will disappear after being exposed to the sun. In addition to covering the surface soil, muslin or glass frames are put in place over the coldframe as soon as the seeding is finished. When glass is used, care must be taken to raise the sashes on warm, sunny days, or the heat generated under the glass may prove fatal to the tender seedlings. If muslin is used it is best to remove it while watering the beds, because if it is left on the beds water collects in the sagging center and seeps through, causing injury to the plants below. Growers using muslin for seed-bed covering should tack it on light frames, for convenience in handling and for economy, as the muslin will last much longer on frames (fig. 2).

It is advisable to remove the covers of the seed bed entirely about one week before transplanting time, if weather conditions are favorable, so as to harden the plants for their subsequent exposure.

The beds should be watered fairly often after seeding, especially if they were steam sterilized and the weather is dry and windy. Although too much water may cause damping off or aid in the development of wildfire, it is not advisable to let the beds become very dry until after the plants have started to grow. It is well to ventilate the beds on warm, sunny days, to destroy mildew and mold growths which may occur in highly fertilized beds.

If the growth of the plants is slow and irregular, or if they assume a yellowish color, this usually indicates a need of plant food. One pound of nitrate of soda to 10 gallons of water sprinkled over a bed of 150 square yards at intervals of four or five days will soon remedy this condition. Liquid chicken manure is also very good for this purpose, but water must be applied freely after the use of these mixtures or the leaves of the plants will be burned. Plants in general should not be forced to grow too fast, because they thus become more susceptible to diseases.[2]

Recent experiments indicate that the dreaded wildfire disease occurring in tobacco may be partially controlled by painstaking care

[2] For detailed information on the control of insects affecting tobacco the reader is referred to the special bulletins of the United States Department of Agriculture on the subject.

of the seed bed. No tobacco grower can be fully assured that he will achieve immunity from wildfire, but the loss may be materially reduced by observing the following precautions:

(1) Steam sterilizing the seed beds and the covers, using a steam pressure of at least 125 pounds for 40 minutes on each section of the bed.
(2) Sterilizing the boards and glass with a solution of 1 part of formaldehyde to 50 parts of water.
(3) Using only seeds that are known to be free from wildfire or else have been sterilized by being twice immersed for five minutes in a 1 to 1,000 solution of silver nitrate. After the first treatment with silver nitrate the seed should be dried before the second treatment is applied.
(4) Frequent and thorough spraying of the plants with Bordeaux mixture from the time the plants are about the size of a dime until transplanting time.
(5) Allowing no one who has been in contact with diseased plants to examine the bed.
(6) Keeping any dried, infected tobacco material from reaching the bed.
(7) Killing out infected spots in the bed by using a solution of 1 part formaldehyde to 50 parts of water.
(8) Using only plants from beds free from disease.

FIELD PREPARATION

Plowing the fields to be planted in tobacco is usually performed early in May and is followed by rolling and disking in order to crush the clods and pulverize the soil. A special implement is much used for this purpose. It is desirable to repeat the rolling and disking after heavy rains, so as to conserve soil moisture and kill the weeds upon which cutworms feed. If commercial fertilizers are used they should be applied broadcast over the field about a week or 10 days before transplanting and thoroughly worked into the soil by harrowing, after which the field is put in a smooth, level condition. When the soil has been treated in this manner it is necessary only to loosen the surface by a light disking when ready to plant, following the disk with a plank or drag.

The soil should not be worked when wet, since permanent injury may result. It is far better to allow the soil to dry for a few days.

Deep and careful plowing is the rule among Pennsylvania growers, and they believe in the adage that "most of the cultivation should be done before planting." Fall plowing is not practiced to any extent, mainly because of the fact that the manure derived from winter steer feeding is not obtainable until spring.

TOBACCO FERTILIZERS

Stable manure, largely derived from winter steer feeding or from dairying, is the most common fertilizer used in the cigar-filler producing districts and to a large extent in the cigar-binder districts. Manure has certain beneficial effects upon practically all soils, increasing their water-holding capacity and otherwise improving their physical properties. In ordinary farm practice it gives back to the soil only a fraction of the plant food removed by crops. While manure aids in maintaining the productiveness of the farm, the quantity available normally can not greatly increase productiveness as a whole, for where it is used on some fields in quantities needed actually to increase production, other fields equally in need will receive none.

Manure, moreover, contains a considerable quantity of chlorine, and as it generally is applied to the tobacco fields in the spring, to be plowed under immediately, or in some cases is used as a top-dressing, the chlorine absorbed by the plant may damage the burning qualities of the tobacco to a greater extent than is realized. An obvious remedy would be to apply the manure to the fields during the fall.

Fertilizer experiments conducted in several of the tobacco-producing districts in Pennsylvania during the last 15 years have shown that when certain quantities of commercial fertilizer, derived mainly from organic sources and free from chlorine, are used in addition to manure, the yields per acre may be considerably increased and the quality of the leaf much improved. On the other hand, when commercial fertilizers high in chlorine content are used for tobacco, the quality is lowered, the burn especially being poor, even though the yield per acre is increased. When it is understood that chlorine injuriously affects the burn of tobacco and that good burning quality is one of the essential factors in determining the value of cigar-leaf tobacco, the importance of using fertilizer practically free from chlorine may readily be seen.

In the experiments it was found that on the plots to which an application of 500 pounds of cottonseed meal, 300 pounds of superphosphate (acid phosphate) of the 16 per cent grade, and 200 pounds of sulphate of potash per acre was made, in addition to 10 tons per acre of manure, the yield was increased as much as 600 pounds per acre over the yield obtained where nothing but 10 tons of manure per acre was applied. In addition, the tobacco grown on the former plots was much better in burn and quality.

It should be noted that the results were much the same over a period of years on different soil types, whichever variety of tobacco produced in Pennsylvania was used.

The use of lime did not seem to affect the burn or yield to any appreciable extent, but it is believed that lime is more beneficial if applied the year before the land comes into tobacco. Heavy liming may favor the development of black root rot.

TRANSPLANTING

In Pennsylvania transplanting is generally performed by the use of a machine, very little, if any, being done by hand. The machine does the work much better than it could be done by hand, and it waters the roots of the plants if necessary. It is drawn by two horses and carries a driver and two setters who alternately place plants in the row. There are several makes of this machine, but the one most generally used has a V-shaped plow which opens a furrow into which the plants are set and held in place with the hand until the soil has been packed around the roots by means of two paddle-shaped blades or wheels which follow the plow and draw the soil up, slightly compacting it. By means of gears on the wheels regulated quantities of water are poured at intervals, indicating where plants are to be set. The machines should always be overhauled before the transplanting begins, so that they are in good working condition, being adjusted to the size of the plants and the condition of the soil.

Transplanting usually begins about the latter part of May in the cigar-filler districts and about the middle of June in the cigar-binder districts, depending on weather conditions and the growth of plants in the seed bed. As a general rule, however, it is advisable to start the planting as early as possible, because the tobacco may then be harvested earlier, obviating damage from frost and insuring better curing conditions. The plants are about the right size for transplanting with a machine when they are 5 to 6 inches high and have developed five to seven leaves. It is of some importance to select strong and healthy plants with good root systems, because plants with inferior roots are handicapped from the start and may cause much replanting and a poor stand.

The beds should be watered thoroughly before the plants are pulled, so that the roots may be drawn up as nearly intact as possible. The plants should be placed in neat, straight layers in boxes or baskets and kept away from the direct rays of the sun. It is not advisable to keep the plants in the containers very long, because if kept more than 24 hours they become wilted and unfit for use.

Broadleaf or cigar-filler tobacco is usually planted in rows from 36 to 42 inches wide, while the distance between the plants in the row varies from 20 to 32 inches. Havana Seed or cigar-binder tobacco is set in rows 36 inches apart, and the distance between the plants in the row is from 16 to 20 inches.

In addition to soil conditions, weather, and the general vigor and growing habits of tobacco, the number of plants grown on a given area, which is determined by the spacing of the plants, may greatly affect the yield. Plants given somewhat more space than usual will grow to a greater size than if crowded, other conditions being equal. With less space than usual, plants will fall below normal in development. Furthermore, if the plants are set too close, cultivation difficulties ensue, as the leaves extend and droop, with the result that cultivation has to be stopped too early or the lower leaves are damaged. A number of experiments to determine whether a closer spacing than usual would increase the acre yield were conducted for several years in Pennsylvania, and the results showed that closer planting than usual increases the yield to some extent, but the length or size of the leaves becomes less.

CULTIVATION

Tobacco growers in Pennsylvania begin to cultivate the tobacco fields as soon after transplanting as the condition of the soil will allow. This first cultivation is generally performed by running a side harrow or cultivator as close to the plants as possible without covering them with dirt, harrowing deep and wide. This procedure is repeated after heavy rains and should be done often, especially during dry weather, so as to keep a fine mulch on the surface of the soil in order to conserve soil moisture. The aim of the grower should be to keep the soil mellow and soft, which necessitates frequent hoeings, usually performed by aid of the hoeing machine, which is drawn by two horses and carries a driver and another man to operate the hoeing device. (Fig. 3.)

The tobacco plant is a surface grower, with few deep roots, and the root system is small in comparison with the large leaf surface.

Most of the roots are found in the upper parts of the soil, and it is therefore not advisable to cultivate deeply after the plants have begun to attain some size, since broken roots will stunt their growth. The crop is cultivated until the leaves have become so large that a horse can no longer pass between the rows without breaking them.

Because different soils require different treatment, and also because of the effect of weather conditions, no hard and fast rules can be laid down for cultivation. As a general rule, however, it should be noted that tobacco responds readily to intensive cultivation when intelligently practiced.

TOPPING

By topping is meant the removal of the flower bud and topmost branches of the plant in order to force a better development of the remaining leaves, for if the plant is allowed to flower the nutritive

FIGURE 3.—Cultivating tobacco with an implement fitted with a hoeing device

materials are gradually transferred from the leaves and used for the formation and production of seed.

The yield and the quality depend to a certain degree upon the method of topping. If the plant is topped too high, the upper leaves can not develop to a proper size and the ripening is delayed. If the topping is very low, the yield is lowered, and leaf spots are often caused from an excess of nitrogen. In the experimental work high topping has been found to increase yield and quality considerably, but only where sufficient plant food for vigorous growth was provided. By high topping is meant leaving from 16 to 18 leaves on the stalk, and by very low topping it is meant that 10 to 12 leaves are left.

The time of topping has also been found to have some influence on the subsequent development of the plant, as shown by measurements taken a number of times during the growing season. These

measurements indicate that the stem continues to elongate even after the first flower appears, but that the portion of the stalk bearing the eighth to the fifteenth leaf makes the greatest increase in length. Topping arrests the growth of the plant and affects to the greatest degree the portion bearing the eighth to the fifteenth leaf. A distinct increase in the length of the internodes, or distances between the leaves on the plant, occurs after the first bud appears.

SUCKERING

In a few days after the plants are topped, suckers (lateral branches growing out of the axils or junctions of the leaves and stalks) begin to appear. They represent the efforts of the plant to reproduce itself and appear first in the axils of the upper leaves and later in those of the middle and lower leaves. The suckers are usually removed twice, but in the interest of better quality and increased yield it is advisable to remove them oftener, because they usurp the vitality of the plant by diverting plant food and water from the leaves. These facts were well shown at the experiment field near Lock Haven, Pa., where two plots were planted with Broadleaf tobacco in order to demonstrate the value of suckering tobacco. The plots received identical treatment, except that one plot was suckered three times and the other was not suckered until just before harvesting. The result was a difference of 330 pounds per acre in favor of the suckered tobacco. The difference in quality in favor of the suckered tobacco was even greater than the difference in yield.

HARVESTING

The changes in the plant resulting from topping are most noticeable in the top leaves, which grow to almost the same size as the middle leaves. Later the bottom leaves shrink and die away or remain as shreds, while the middle leaves begin to take on a somewhat lighter color. The upper leaves ripen last, since the ripening process progresses from the lowest leaf upwards. Finally, the leaves thicken and assume a swollen, mottled appearance, which indicates clearly to the experienced eye that harvesting time is at hand.

In the cigar-filler districts the tobacco is cut in the field by means of long-handled shears, but in the binder districts hatchets are used. The shears are better than hatchets for this purpose, since the stalk may be cut closer to the ground without injury to the leaves. Shears are also easier to handle and allow quicker work.

Cigar-filler tobacco, if set out in the field early in June, ripens early in September, or about one month after topping, provided weather conditions are normal. Cigar-binder or Havana Seed tobacco is usually transplanted during the middle of June and is allowed to stand about three weeks after topping.

The tobacco in the field is not cut until the dew has dried off the leaves in the morning, and harvesting during foggy or rainy weather is avoided because it prevents proper wilting. After being cut down, the plants are allowed to lie until the leaves have been wilted by the sun so that they can be handled without breaking. Care must be taken that the wilting is not too protracted, as there may be damage from sunburn, indicated by dark-brown spots on exposed leaves. In

the cigar-filler districts, when the leaves are wilted sufficiently the stalks are grasped at the butt and strung on laths by means of a detachable iron spear, five to six stalks being placed on each lath. (Fig. 4.) Care is taken not to thrust the spear through any leaves. The laths bearing the plants are then hauled to the curing sheds on wagons fitted with racks known as tobacco ladders.

In some of the cigar-binder districts the tobacco, after being cut and wilted, is placed on a flat wagon body and hauled to the curing shed, where each stalk is tied by strings to the poles in the shed. This method is somewhat crude and increases considerably the proportion of damaged leaves.

FIGURE 4.—Harvesting tobacco in Clinton County

CURING

Extensive research relative to tobacco curing has developed the fact that it is essentially a slow-starvation process, with a corresponding loss of the leaf moisture. The changes that take place in the leaf tissues are developed from conditions prevailing while the leaf cells are slowly dying and after their death.[3]

It is evident that weather conditions control these changes to a considerable extent, and unless the curing sheds are built so that the entire structure can be fully ventilated on short notice, or closed reasonably tight when necessary, there is great danger of damage by poleburn or pole sweat, molds, white vein, and the like. Poleburn, sometimes called shed burn, attacks tobacco during the earlier stages of curing when the temperature rises above 60° F., and the relative humidity must be 80 per cent or higher and the tobacco has reached the yellowing stages. Experiments have shown that if artificial

[3] GARNER, W. W. TOBACCO CURING. U. S. Dept. Agr., Farmers' Bul. 523, 24 p., illus. 1922. (Revised ed.)

heat is applied in the shed when these three conditions are present and the beginning of poleburn is indicated by an offensive odor accompanied by strutting or stiffening of the leaves, the relative humidity is reduced and the danger of damage eliminated or greatly reduced. A temperature 15° to 20° higher than that of the outside must be maintained as long as these conditions prevail.

As constructed in Pennsylvania, many curing sheds afford only a very clumsy, inefficient way of controlling moisture conditions during the curing process, and very few growers use artificial heat in order to reduce damage from poleburn.

It usually takes from six to eight weeks to complete the curing process, and sometimes, when the tobacco has been harvested late, it may take longer. Late tobacco, as a rule, does not cure as well as early tobacco, and it frequently contains "fat stems" or stems only partially cured. Occasionally these fat stems freeze, and when thawed out moisture is deposited on the leaf tissues along the stem, causing damage by decay. Excessive moisture in the shed also favors development of mold on the leaf veins. When fully cured the leaves are brown in color, with the midrib and veins toughened and reduced in size, and the stalks have begun to turn black.

STRIPPING

Pennsylvania tobacco is usually taken down from the poles and stripped, sized, tied in "hands," and baled during December, January, and February, delivery being made to the buyer as soon as these operations are completed, if the crop is sold. The tobacco must contain a certain percentage of moisture before it can be handled without breaking, and the growers are frequently compelled to use water on their tobacco so as to get it in the right condition for subsequent operations. This practice is severely condemned by the leaf packers, and not without reason, because extreme caution is needed when water is used on tobacco, and an excess of moisture may cause damage from black rot, mold, and stem rot during the sweating process. It has been shown by experiments conducted in Lancaster County that cigar-leaf tobacco should contain on the average not less than 22 per cent and not more than 26 per cent moisture in order to ferment properly. A higher percentage of moisture almost invariably causes black rot or other damage, and a smaller percentage results in insufficient fermentation.

It is a well-known fact that in cold weather tobacco contains more moisture than is indicated by its appearance until it has been placed in a warm room, when it soon becomes soft and pliable. Hence, growers should not attempt to use water on their tobacco unless it is absolutely necessary, and when it is applied the utmost caution should be observed. Thousands of pounds of tobacco are damaged annually through the improper use of water in stripping and handling.

When the tobacco is taken from the poles in the cigar-filler districts the dampening cellar is first filled. This cellar is usually located under the curing shed adjoining the stripping cellar and often extends under the entire shed. For greater convenience in handing down laths a trapdoor connects the cellar with the floor above. After the dampening cellar has been filled the laths are piled on the

floor of the shed in such a manner that the tips of the leaves are inside the pile and the butts of the stalks on the outside. After the laths have been stacked in a 5-sided pile to a height of 5 or 6 feet the pile is covered, to retain moisture as long as possible. This work is generally performed during damp weather, but sometimes cold north winds may dry out the tobacco in the piles so that it can not be handled without breaking, and under such conditions water is applied to render the leaves pliable. The only safe way to soften the tobacco is to hang the laths fairly close together on the lowest tier in the shed and apply water sparingly over the butts by means of a sprinkling can. After the surplus water has drained off, the laths may be placed in the dampening cellar, and under favorable conditions the tobacco will be ready to strip in 12 hours. During extremely cold weather it takes considerably longer. To place the laths on the floor and to sprinkle them there, as is sometimes done, causes water stains and later black rot and other damage. Some growers, without using any water at all, let their tobacco hang in the dampening cellar for long periods, which practice also should be avoided, since it has precisely the same effect on the tobacco as excessive use of water.

The dampening and stripping cellars should be kept scrupulously clean at all times and no rubbish allowed to accumulate. In fact, the entire shed should be kept clean and all trash burned, as it has been shown that wildfire germs live in such material.

As soon as the tobacco is sufficiently soft to be handled without breaking the leaves it is brought to the stripping room. The tobacco stalks are then removed from the laths and the leaves stripped off, beginning with the lower leaves and proceeding thence to the middle and upper leaves of the stalk. After the leaves have been stripped from the stalks they are sorted into grades according to the quality of the tobacco. All clean and uninjured leaves, free of blemishes, from the middle and upper part of the plant are kept separate. These leaves are locally known as wrappers, although they are used chiefly for cigar fillers. Some farmers and dealers select from the so-called wrappers of Broadleaf the better qualities of thin and silky leaf, known as tops or Wrapper B's, to be sold to the manufacturers as cigar binders or stogie wrappers. The leaves from the lower part of the plant are usually inferior in quality, dead or low in oil, and lusterless. These leaves, known locally as fillers, are kept separate. The dirty, badly injured, and otherwise inferior leaves that are thrown out of the wrappers are worked in with the fillers. The very inferior leaves that are so badly injured that they can not be tied in hands are known as "Trash" and are kept separate from the wrapper and filler grades.

The United States Department of Agriculture, in connection with its tobacco-standardization studies, has prepared four major grades, known as "groups" or "groups of grades," for Pennsylvania Broadleaf and five for Pennsylvania and New York Havana Seed. These groups are as follows:

Groups of Broadleaf, U. S. Type 41	Groups of Havana Seed, U. S. Type 53
B, Binders or tops (Wrapper B's).	A, Wrappers.
C, Fillers (Pennsylvania B's).	B, Binders or seconds.
X, Stemming (farmer's fillers).	C, Fillers (Onondaga B's).
Y, Trash or ground leaves.	X, Stemming (farmer's fillers).
	Y, Trash or sand-leaf fillers.

The wrapper leaves (A, B, and C groups) and sometimes the filler leaves (X group) are sized or sorted for length by being placed one by one in a sizing box fitted with small partitions graduated in length at 2-inch intervals from 14 to 32 inches. Standard tobacco sizes have been prepared which are applicable to both United States types 41 and 53 of Pennsylvania tobacco. One of the series of standard sizes is as follows:

U. S. size 15, from 14 to 16 inches.
U. S. size 17, from 16 to 18 inches.
U. S. size 19, from 18 to 20 inches.
U. S. size 21, from 20 to 22 inches.
U. S. size 23, from 22 to 24 inches.
U. S. size 25, from 24 to 26 inches.
U. S. size 27, from 26 to 28 inches.
U. S. size 29, from 28 to 30 inches.
U. S. size 31, from 30 to 32 inches.

After sizing, the leaves are tied into "hands," from 14 to 18 leaves making a hand. The tobacco is then carefully packed in the baling box, a contrivance with collapsible sides, lined with paper and furnished with a lever operating the pressing mechanism. From 50 to 70 pounds of tobacco is pressed into the bale, which is then tied with three or four strings, the paper covering all but the ends of the bale. The bale is taken out and placed on the floor above, until the entire crop is ready for delivery.

During these operations it is of importance to have the leaves kept smooth and straight at all times, since the shape of the leaf assumed at this time will be retained during the subsequent operations, and unless care is exercised in this regard the appearance of the tobacco will be detrimental to its sale. Carelessness in sizing and tying the tobacco is to be avoided, and it can not be too strongly emphasized that it costs no more to handle the tobacco neatly than it does to perform the work in a slovenly manner.

Tobacco bales should be piled not more than two high, since the tobacco may be damaged by heating, and the practice of storing bales in the damp atmosphere of the stripping cellar also is liable to cause serious damage.

In the cigar-binder districts the stripping of tobacco is usually deferred until a protracted period of rainy weather occurs, since no dampening cellars are used, except in Clinton and Lycoming Counties. It is also necessary to use damp blankets or coverings in order to get the tobacco in a soft condition, and many growers use steam in their stripping rooms. In Clinton and Lycoming Counties the method of handling tobacco is similar to that in the filler districts, but in Tioga and Bradford Counties no grades are made, the loose leaves being packed in bales without any previous grading.

MARKETING

By far the largest proportion of the tobacco produced in Pennsylvania is sold on the farms where it is grown. The buyers usually appear while the stripping is in progress and examine the tobacco thoroughly, investigating the burn or combustion of the leaves with their tallow candles. They offer a certain price for the fillers and for the wrappers, the crop to be delivered to their warehouses as soon as it is stripped and baled. (Fig. 5.) The contract usually stipulates that the tobacco shall be free from damage when delivered. When there is a scarcity of tobacco it is often bought in the field, before

curing. Some growers pack their own tobacco and sweat it or engage a packer to do this for them.

TOBACCO-PLANT DISEASES[4]

The mosaic disease is one of the most baffling of all diseases affecting the tobacco plant. It has various local names, such as calico, gray top, mottled top, brindle, and mongrel, suggestive of the local manifestations of the disease, and it occurs wherever tobacco is grown. This disease has been found to be highly infectious, being easily transmitted from diseased to healthy plants by laborers in transplanting, topping, and suckering. It is also transmitted from diseased to healthy plants by aphids and other insects. An infected plant will not recover, and though it does not die, the yield will be reduced and the quality inferior. For control measures it is suggested that all infected plants be pulled up and burned or otherwise

FIGURE 5.—Delivering tobacco in bales to the warehouse in Lancaster

destroyed, and those handling diseased plants should wash their hands with soap and water before coming into contact with the healthy plants.

The foxy, frenchy, or shooting-star disease is generally mistaken for mosaic, but has different symptoms, such as narrow, thick, and small leaves having numerous yellow spots. Such leaves grow erect like the ears of a fox. This disease is due to malnutrition, apparently caused by unfavorable soil conditions and defective drainage. It is not infectious.

Root rot is caused by a fungus known as *Thielavia basicola*, which lives as a parasite on the roots and is the source of a gradual blackening and decay of the root system, which reacts on the plant by stunt-

[4] For additional information on tobacco diseases, see the following: GARNER, W. W. TOBACCO CULTURE. U. S. Dept. Agr., Farmers' Bul. 571, 22 p., illus. 1925. (Revised ed.)

ing its growth. In the absence of tobacco the parasite attacks clover, cowpeas, and other legumes. It has been known to exist in the soil on dead organic material from 5 to 10 years. Therefore, crop rotation does not wholly prevent the disease, though it may check it to some extent. Low temperatures are favorable to the development of the disease, and high temperatures check it. It is frequently developed in the seed bed and carried to the fields by transplanting, by farming tools, and by the wind. A thorough sterilization of the seed beds, with either steam or formaldehyde, will destroy this organism, but sterilization of an infected field is not practicable. It has been found, however, that there is a marked difference in the susceptibility of different varieties and strains of tobacco to root rot, and by the careful breeding of resistant strains the disease has been rendered less damaging. (Fig. 6.)

FIGURE 6.—Tobacco field badly affected with root rot

There are numerous leaf-spot diseases, which are known by such names as "frog eye," "brown rust," "blight," and "wildfire." Some of these are due to certain germs, but others are caused by malnutrition. Among the factors concerned in bringing about severe outbreaks of some of these spot diseases are fertility of soil, fertilizers used, weather conditions, and the maturity of the crop. An abundant supply of ammonia or fertilizer in the soil predisposes the tobacco to injury, and low topping may also result in leaf spot, since the relative proportion of ammonia is thereby increased. Potash is of some value in reducing injury, but it must be supplemented by the application of less ammonia in the fertilizer and by higher topping. Wildfire and related leaf spots seem to originate in the seed bed and are due to germs. Wet weather is the principal factor in causing serious damage in the field from these diseases.

SEED SELECTION

Growers are paying more and more attention to systematic selection of seed plants, based on uniformity of type, resistance to disease, and other desirable features. Tobacco-growers' associations are doing valuable work in this direction by growing and selecting their own seed from plants known to possess these qualities and by recleaning and distributing the seed to members and others desiring it. Cigar-manufacturing interests also are beginning to indicate a desire for standardized types of cigar-leaf tobacco having the qualities necessary for the manufacture of cigars. (Figs. 7 and 8.)

FIGURE 7.—Plant of the Pennsylvania Broadleaf or Seed Leaf variety, used for cigar-filler purposes. The upper leaves have been removed in preparation for bagging the seed head

Systematic selection of seed plants includes choosing plants of good and uniform growth, basing the choice on points of superiority over other plants, such as greater number of leaves per stalk, more desirable shape of leaf, small size of veins in the leaf, greater length of stalk, long internodes or spaces between the leaves on the stalks, small extent of heel or area of leaf at the point of attachment between leaf and stalk, and early maturity. The final selection is made by marking the most desirable plants just before the plant flowers, taking into consideration the size and number of suckers and discarding the plants showing a strong sucker growth. Before the flowers open, all shoots except the central prong, together with as many leaves as would be removed in topping, are broken off. A light manila paper bag, 25-pound size for Seed Leaf and 12-pound size for Havana Seed, is then placed over the flower head, tied securely but loosely, so that it can be pushed up as the plant grows, and with a few small holes punched in it to allow ventilation. The object of bagging the flower head is to prevent insects from cross-fertilizing the flowers and to force self-pollination, thus transmitting the charac-

teristics of the selected plant to the next generation. The bag must be pushed up on the stalk from time to time, because when the flower head meets the resistance of the bag it is forced to grow downward, which may prevent proper pollination.

In the districts where crop rotation is practiced the seed stalks must be removed from the field so that it can be seeded. The stalks are therefore pulled up and removed to a trench on the edges of the field, until the seed pods turn brown, which indicates that the seeds are ripe. The portion of the stalk bearing the seed pods is then cut off and hung up to dry in the shed, care being taken to protect the stalk against rats and mice, since these rodents seem to have a natural fondness for tobacco seed. When dry, the seeds are shelled out, screened, and subjected to air currents, either in a glass tube by means of bellows or in a more convenient machine operated by an electric fan. This process removes all chaff, dirt, and immature seed of light weight.

FIGURE 8.—Pennsylvania Havana Seed plant. This tobacco is used for cigar binders. The upper leaves have been removed in preparation for bagging the seed head

FERMENTATION OR SWEATING PROCESS

All types of cigar-leaf tobacco are subjected to a fermentation process before being manufactured into cigars, and some confusion exists regarding the proper name for this procedure. Frequently it is called "curing," which is not correct, as this term properly applies to the attrition process that green tobacco undergoes in the curing sheds after harvesting. The generally adopted popular term for the fermentation process is "sweating," which, in addition to being a terse description, is also used by the trade to a great extent. Sweating is essential to cigar-leaf tobacco because it removes the harsh, raw taste and develops the flavor and aroma inherent in the leaf. The greenish color disappears and the tobacco loses some of its nicotine and from 10 to 15 per cent of its weight. The loss and changes of the chemical constituents of the leaf

are considerable. The process has not been thoroughly investigated, though it offers an inviting field to the scientist.

Although all cigar-leaf tobaccos are sweated, the intensity of the process is less severe in wrapper and binder tobaccos and higher in filler tobaccos, since a hard sweat darkens the leaf, which is undesirable in wrappers and binders.

Three methods of sweating—namely, natural sweat, force sweat, and bulk sweat—are practiced in the northern cigar-leaf tobacco districts, which include Pennsylvania, Ohio, Wisconsin, New York, and the Connecticut Valley.

Natural sweat, which is the method most commonly used in Pennsylvania, is accomplished by packing very tightly and carefully from 300 to 400 pounds of tobacco, properly graded, into wooden boxes which are fairly tight on the sides but with ½-inch spaces between the end boards. These boxes, or cases as they are commonly called, are 30 inches high, 30 inches wide, and vary in length from 33 to 52 inches, depending on the size or length of the tobacco to be packed. The moisture content of the leaf when cased should be between 24 and 26 per cent, because a higher percentage may cause black rot and other serious damage, whereas tobacco containing a lower percentage of moisture does not sweat sufficiently. The inside of the case is covered with heavy paper, except on the ends, in order to retain moisture and facilitate the inspecting and sampling later, and the hands of tobacco are packed neatly with the tips meeting and overlapping in the center and with the butts toward the ends, leaving a 1½-inch space between the butts and the end boards of the case. A removable frame is placed over the top of the case, so that the required number of pounds of tobacco necessary to fill the case may be packed in and pressed down by means of a large press operated with levers, after which the lid is nailed on and the case stenciled with its number, weight of case, and gross weight. (Fig. 9.) The cases are then stored in warehouses which are usually unheated, being stacked from 5 to 20 cases high, by means of block and tackle or traveling cranes. The packing operations are usually conducted during late winter and early spring, and the cases are left undisturbed until the following fall, when they are inspected and sampled.

In forced sweating the cases are kept in a room heated to 90° to 120° F. for six to eight weeks. The temperature is allowed to decrease slowly as the sweating progresses, and artificial heat is omitted during the summer. Sometimes water is sprinkled on the floor to supply needed moisture, or steam may be used for the same purpose. The cases are opened and inspected during late summer, so that any damaged tobacco may be removed before the official sampling is performed.

The bulk method of sweating tobacco as practiced in Pennsylvania consists of building up layers of tobacco on a slightly raised platform 10 to 12 feet long and 6 feet wide, in a room heated to 70° to 80° F. Headboards are provided on the ends of the platform in order to keep the bulk from falling and to facilitate the work of erecting it. The hands of tobacco are packed neatly and evenly in overlapping rows with the butts toward the sides of the bulk, which is then built up, layer by layer, until it is 5 to 7 feet high. It is then covered with rubber blankets to retain the moisture. The bulk is

not disturbed except occasionally when it is tested for possible overheating by the simple expedient of thrusting the hand through the center. Some of the more progressive packers insert thermometers in the bulk and keep a record of the temperature, and when it reaches 114° inside the bulk the tobacco is packed in cases, which are then stored in the warehouse, which is usually unheated, in order to complete the sweat. The main object of bulk sweating as practiced in Pennsylvania is to reduce the moisture content of the tobacco, thus minimizing the damage from black rot, must, and molds. (Fig. 10.)

In the Connecticut Valley bulk sweating is conducted on more scientific lines, though confined chiefly to shade-grown tobacco. Here the temperature and relative humidity are controlled much better and are kept at higher levels. A thermometer is inserted in the center of the bulk, and when the desired temperature has been

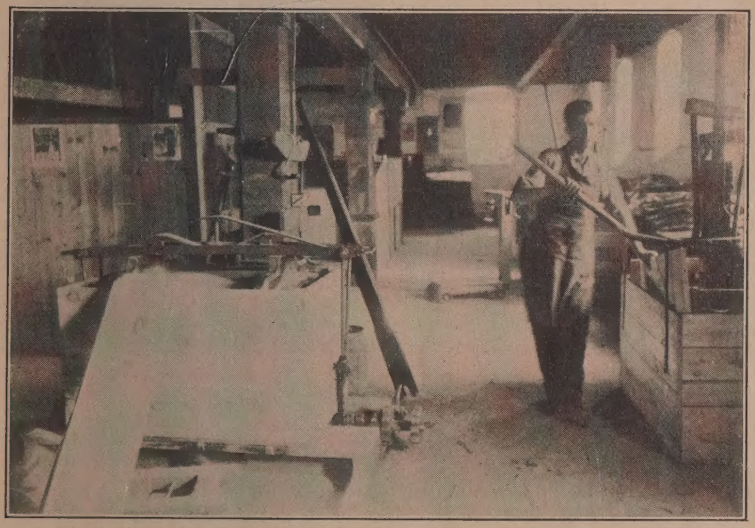

FIGURE 9.—Interior of a tobacco warehouse in Pennsylvania, showing method used in packing tobacco

reached the bulk is pulled down, the hands of tobacco shaken gently, and a new bulk built by putting the tobacco that was on the outside of the first bulk on the inside of the new one, so that every hand of tobacco will receive about the same degree of sweating. This operation of rebuilding the bulk is continued until the tobacco is properly sweated. If the temperature of the sweating room is kept at a minimum of 90° F. and the relative humidity at about 80 per cent, the temperature of the original bulk should reach 120° in five days, provided the tobacco is in good condition. If it is too moist the temperature of the bulk will rise very quickly, necessitating its immediate rebuilding in order to dry out the tobacco before it gets damaged. The temperature of the bulk rises more slowly on the second and successive turnings, and sometimes it becomes necessary to add water in order to induce sweating.

A comparison of the three methods of sweating tobacco here outlined would naturally seem to favor the complete bulk sweat, because the tobacco is at all times under control, whereas tobacco undergoing a natural or even a forced sweat is subject to serious damage, owing to the haphazard methods employed; indeed, the annual losses from black rot alone are rather high.

Cigar manufacturers and leaf packers, however, object to bulk-sweated filler tobacco on the ground that it causes the tobacco to become what they term "bony," or lacking in elasticity and in the

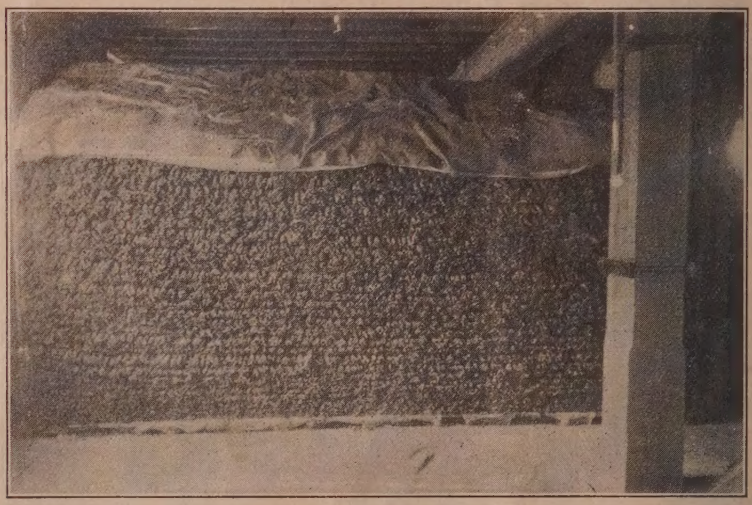

FIGURE 10.—Bulk sweating of tobacco as practiced in Pennsylvania

power to absorb moisture while being manufactured. It is difficult to understand why this should be a fact, since all cigar-filler tobacco must be resweated before being made into cigars.

Resweating consists of dipping each hand of tobacco either in pure water or in some solution of a jealously guarded formula. The surplus moisture is drained off and the tobacco packed back into the cases, which are subjected to high temperatures for a period of two to three weeks, the tobacco then being ready for the cigar manufacturer except for the finishing touches at the factory.

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
U. S. GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
5 CENTS PER COPY